**PhD. SYNOPSIS**

# Precision Nutrition Approach For Prevention and Management of Obesity


Submitted by

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According to the World Obesity Federation, globally 800 million people are obese, with a billion more at risk of becoming overweight or obesity. It is estimated that the global prevalence of obesity nearly tripled between 1975 and 2020. The World Health Organisation predicts that almost half of the world's adult population will be overweight or obese by 2030, if the prevalence of obesity continues on its current trend. The prevalence of obesity in India was recorded at 40.3% amidst its rapid epidemiological transition. (Ahirwar R *et* al., 2019)

Obesity is a chronic, low grade inflammatory condition, with multifactorial etiology including genetics, environment, metabolism, lifestyle, and behavioural components. The current treatments of obesity are not effective and sustainable in terms of weight loss maintenance. (Luhar et al., 2020). The complexity of the nature of obesity could be partly due to the causes which are multi- factorial , where heritability can contribute up to 70 - 80% of the estimated risk of obesity. It is still debatable whether an individual's genetic make-up can play a role in personalized obesity treatment. (Maes, *et* al., 1997) (Elks *et* al.,2012).

Research studies have examined the usefulness of nutrigenetic testing in weight management in the western population. (Franzago et al.,2022) (Zeinalian, R et al., 2022). Although the usefulness of these tests are questionable, there is a huge potential in improving the health outcomes of the individuals complying to the personalised dietary recommendations based on their genetics in treating and managing obesity. Few Indian genetic testing companies offer personalised, targeted nutrition recommendations for obesity-related polymorphisms based on the particular pattern of genetic variation.

It is well understood that there are many factors contributing to the development and perpetuation of obesity and several research studies have demonstrated that the microbes present in the human gut and its key contributions to obesity. There are compelling evidences especially from the animal model studies that have started to elucidate the pathways and mechanisms through which gut microbes contribute to obesity, thus paving forward for future treatments for obesity.

The concept of precision nutrition approach uses personalised information about an individual to provide tailored dietary advice based on genetic make-up, dietary consumption pattern, microbiome, stress, activity levels, biochemical parameters, anthropometric measurements and other omics profiles of an individual. Recent evidences show that this concept of precision nutrition will provide new insights into the pathogenesis of obesity, elucidate the role of gene- host-micrbiome-environment interactions in obesity thus

contributing to a precision approach in prevention and management of obesity. This study is first of its kind in India, based on the results of the previous research findings, attempts to examine the use of precision nutrition approach in combining the genetic make-up and gut microbiome profile of individuals in designing personalised diet recommendations and its potential in improving weight loss.

## CHAPTER SCHEME

### CHAPTER 1 – INTRODUCTION

Prevalence of Obesity, Multifactorial nature of obesity, Precision Nutrition approach in preventing and managing obesity, Genetic Causes of obesity, Gene-nutrient interactions in obesity, Gut microbiome and host interactions in obesity, intervention study comparing the effectiveness of precision diet in prevention and management of obesity, rationale of this study and objectives of the study are discussed briefly in this chapter.

**Objectives of the present study**

**Primary objective**

- To determine whether precision nutrition approach, that includes nutrigenetically tailored and gut microbiome based diet results in improved health outcomes than generic nutrition approach in the prevention and management of obesity.

### Secondary objectives

- To examine the factors influencing consumer acceptance of genetic testing for personalised nutrition in India.
- Development & design of algorithm for formulating a genetic based diet & gut microbiome based diet.
- Evaluate the impact of precision dietary recommendations on long term weight management among obese adults.

### CHAPTER II -REVIEW OF LITERATURE

This chapter comprises of literature on the concept of precision nutrition in obesity – genetics of obesity- Gene Nutrient interactions in obesity – Gut microbiome and dietary interventions in the prevention and management of obesity.

## CHAPTER III – METHODOLOGY

The methodology of the study is presented as follows:

**Phase 1: Base line survey to collect information about attitudes of consumers about preferences of genetic testing for personalised nutrition**

The survey method was used to collect primary information about attitudes and preferences of consumers towards genetic testing for personalised nutrition. Primary data collection was carried out by means of an in person interview method using the survey questionnaire. The data was collected from 500 individuals who had previously visited a wellness clinic in Coimbatore, India and underwent a personalised nutrigenetic test. An email communication was sent to all the individuals who had taken the genetic tests for nutrition in the clinic to know their interest and willingness to participate in the study (n = 1352), out of which 604 individuals consented to participate in the survey. Finally, data was collected from 500 individuals who provided the required information via the interview method.

**Phase II : Comparative study to determine the effectiveness of precision nutrition in long- term weight loss among obese Indian adults**

Healthy men and women with BMI $\geq$ 25-30 kg/$m^2$ with no other co-morbidities were selected for the study. Study participants were grouped into three namely, precision nutrition group (group -1), personalised nutrition group (group -2) and standard diet group (group -3). All the three groups received a baseline standard diet of 1500kcal. The precision nutrition group received dietary recommendations which were further customised based on the genetic make-up and gut microbiome profile, personalised nutrition group received recommendations customised based on the genetic make-up only The standard diet group received a 1500 kcal diet based on the population based dietary guidelines ( Daily recommended dietary allowances) which was further calculated for weight loss.

**Phase III: Assessment of nutritional status of the selected subjects using standardised tools for measurements**

Nutritional status of the study participants was assessed by using standardised tools of measurements. Anthropometric measurements namely height, weight, BMI, waist

circumference was measured. Dietary consumption and dietary pattern was recorded using 24 hour dietary recall method. Food frequency was recorded using food frequency questionnaire in addition to the recall. Biochemical indices of the participants were collected. Clinical signs and symptoms related to weight gain was observed and recorded using a questionnaire.

**Phase IV: Development & design of algorithm for formulating a genetic based & gut microbiome based diet.**

To develop an algorithm for genetic based diet, ten genetic markers related to obesity was selected. SNP selection was based on the systematic review of literature and the genetic markers selected had significant association with obesity. The genetic markers selected were PPARGC1A (rs8192678), AG (rs699), FTO (rs9939609, rs8050136, rs11076023), LIPC (rs1800588), MC4R (rs17782313), CD36 (rs1761667, rs1984112, rs1527479), ADIPOQ (rs17300539), PPARG ( rs1801282), MTHFR (rs1801133), APOA5 (rs662799). Nutrients specific to these genetic markers were identified and given as recommendations as a part of the weight loss diet, 1500 kcal baseline diet.

Gut microbiome based diet was customized for each individual based on these three criteria, gut composition, abundance and diversity of species. Gut composition was analysed mainly comprised of actinobacteria, bacteroidetes, firmicutes, proteobacteria. A higher firmicutes to bacteroidetes ratio was used as an indicator for assessing the risk of obesity and dietary recommendations were designed for such individuals to maintain a balanced ratio. Abundance of species was determined by analysing archaea, eukaryotes and viruses. Specific strains of probiotics and prebiotics were suggested based on the abundance. Diversity of species was improved by appropriate nutrient recommendation specific to the species.

**Phase V: Testing & Analysis**

SNPs were analysed using the exome sequencing method and the gut microbiome profile of the study participants was analysed using the 16sRNA sequencing method. The data collected was recorded, tabulated, consolidated and analysed using appropriate statistical methods.

**Phase VI: Impact Evaluation**

The participants of the study were monitored and measured at 30 days, 60 days and 90 days respectively. BMI and waist circumference were recorded at appropriate time period and analysed to study the effectiveness of the diet. Compliance to the weight loss among the study participants was determined using validated questionnaire. Various statements was used in the questionnaire to assess anticipated psychological and behavioural reactions during their last visit and recorded.

## CHAPTER IV – RESULTS AND DISCUSSION

Characteristics of individuals who participated in the baseline survey are presented as follows, 48% of the participants were males and 52% were females. The mean age was 38.3 ± 14.9 years. The majority of the participants were from the age group between 40-49 years. 36% of the study participants had a university post- graduation degree and 34.8% had a professional degree. Most of the participants had business as their occupation (33.4%) and 25.2% were working in private sectors.

A vast majority of participants reported to be willing to adopt a personalised diet that is based on genetic testing. Moreover, more than 85% of participants who were diagnosed with type 2 diabetes reported to be willing to follow the dietary recommendations based on their genetic makeup. This suggests that individuals identified having a medical condition may be more motivated to comply with dietary intervention that are personalised.

Respondents reported that ease of understanding and specificity of the diet advice was the most frequently reported perceived advantages of nutrigenetic testing (57.5%), followed by more personalised and enjoyable (22.4%) and reduced costs due to disease prevention (20.1%).

Additionally, 23.5% of the study participants perceived no disadvantage to receiving DNA based dietary advice. While reporting about the disadvantages, “adds cost by advising to consume specific foods (45.7% ) was the most frequently mentioned disadvantage followed by “personalised nutrition is much more time consuming” (34.3%) and non-feasibility and difficulty to prepare different foods for different family members (20%).

About 31.2% of respondents feel confident that genetic test-based personalized nutrition helps them to have full control of their health and see it as an attractive option, while nearly 27.6% feel genetic based personalised nutrition has a lot of risks. Nearly 28.2% of them believe that it could help them prevent diseases.

The most commonly selected response among the 500 participants was ‘personalised nutrition could help disease prevention’ (57%), followed by ‘can see more of benefits over drawbacks of genetic based personalised nutrition” (56.4) and ‘personalised nutrition makes me able to live longer in good health’ (52%). The response options used in the questionnaire, ‘personalised nutrition makes me able to live longer in good health’ (Mean response ± SD, 4.17 ± 1.05), ‘personalised nutrition can help disease prevention’ (Mean response ± SD, 4.43 ± 0.79) and ‘If I weigh up the benefits and drawbacks of genetic based personalised nutrition, I can see more of benefits ((Mean response ± SD, 3.98 ± 1.05). Trends in increases toward the positive end of the scale were observed for the statements.

The comparative study results showed that BMI and waist circumference were measured at regular intervals, 30 days, 60 days, 90 days and 120 days in both groups. During the first 30 days of weight management intervention, the records demonstrated that two groups were very similar. The precision nutrition group showed significant reduction in waist circumference at 60 days and 90 days respectively compared to the personalised nutrition group and the standard diet group.

There was a tendency for the precision nutrition group to have a greater reduction in the waist circumference after 60 days and after 90 days compared to the non-nutrigenetic group, resulting in an age and gender adjusted odds ratio of 5.74 ($P< 0.003$) and 4.98 ($P < 0.007$) respectively. Similar results were observed in the BMI reduction in the precision nutrition group compared to the other two groups.

The gut microbiota composition changes were determined at regular intervals, 30 days, 60 days, 90 days and 120 days respectively. No significant changes were observed between 30 days and 60 days. Significant changes were observed between 30 days and 60 days. Prominent changes were observed the records taken after 60 days, 90 days and 120 days. The percentage of firmicutes increased gradually from 18.62% to 23.4% to 28.6% respectively, whereas percentage of bacteriodetes increased from 3.98 % to 4.62 % to 5.12% respectively.

## CHAPTER V: SUMMARY & CONCLUSION

It may be concluded that individuals with personal history of chronic disease have a heightened perceived susceptibility to disease and seem to have a positive outlook towards

genetic based personalised nutrition. Majority of our study participants perceived many advantages to nutrigenetic testing (mainly health reasons).

They are generally aware of the potential privacy issues of nutrigenetic testing, but do not seem to fully understand the risks associated with the ownership of personal genetic information. The findings further support that the study population is generally optimistic regarding the use of nutrigenetics in health care practice, preferably routed through health care professionals especially via registered dietitians.

Several risks have been identified in relation to the genetic testing for personalised nutrition by the consumers, which needs to be adequately addressed through effective communication to overcome individuals' fear while designing and implementing gene based personalised nutrition services. A realistic and pragmatic approach to ensure the consumers are motivated to engage these services. Awareness creation, public education, counselling regarding genetic testing for multifactorial diseases, personalised nutrition to optimise health and disease prevention are likely to help to improve uptake and acceptance of a nutrigenetic-based personalised nutrition services.

The findings of this study suggest the use of nutrigenetic testing and gut microbiome testing to be a useful tool in weight management and long term compliance of dietary changes. Adding a personalised aspect to weight loss program not only improves motivation and compliance but also helps to optimise the intake of macro and micronutrients of an individual.

## REFERENCES


1. Ahirwar R, Mondal PR, Prevalence of obesity in India: A systematic review. Diabetes MetabSyndr. 2019 Jan-Feb;13(1):318-321.
2. Cathy E. Elks1, Marcel den Hoed1, Jing Hua Zhao1, Stephen J.Sharp1, Nicholas J. Wareham1, Ruth J. F. Loos1 and Ken K.Ong, Variability in the heritability of body mass index: a systematic review and meta-regression. Front. Endocrinol, 2012, 3, 29.
3. El-Sohemy A. Nutrigenetics. Forum Nutr. 2007;60:25-30. doi: 10.1159/000107064.
4. Franzago, M., Di Nicola, M., Fraticelli, F. et al. Nutrigenetic variants and response to diet/lifestyle intervention in obese subjects: a pilot study. Acta Diabetol, 2022, 59, 69–81.

5. Gollust SE, Gordon ES, Zayac C, Griffin G, Christman MF, Pyeritz RE, Wawak L, Bernhardt BA. Motivations and perceptions of early adopters of personalized genomics: Perspectives from research participants. Public Health Genom. 2012. https://doi.org/10.1159/000327296.

6. Hardie EA. Australian community responses to the use of genetic testing for personalised health promotion. Aust J Psychol. 2011. https://doi.org/10.1111/j.1742-9536.2011.00017.x.Xi'an ShiyouDaxueXuebao (ZiranKexue Ban)/ Journal of Xi'an Shiyou University, Natural Sciences Edition. ISSN:1673-064X E-Publication:Online Open AccessVol: 65 Issue 03 | 2022. DOI 10.17605/OSF.IO/RDBNP March 2022 | 264.

7. Nielsen DE, El-Sohemy A. A randomized trial of genetic information for personalized nutrition. Genes Nutr. 2012;7(4):559-566. doi:10.1007/s12263-012-0290-x.

8. Neale, M. C. & Eaves, L. J. Genetic and environmental factors inrelative body weight and human obesity, Behav. Genet,1997, 27, 325–351.

9. Ronteltap A, van Trijp JCM, Renes RJ, Frewer LJ. Consumer acceptance of technology-based food innovations: Lessons for the future of nutrigenomics. Appetite. 2007. https://doi.org/10.1016/j.appet.2007.02.002.

10. Szakály, Z., Kovács, B., Szakály, M. et al. Consumer acceptance of genetic-based personalized nutrition in Hungary. Genes Nutr 16, 3 (2021). https://doi.org/10.1186/s12263-021-00683-7.

11. Tai ES, Gillies PJ (eds): Nutrigenomics - Opportunities in Asia. Forum Nutr. Basel, Karger, 2007, vol 60, pp 25-30. doi: 10.1159/000107064.

12. ShammiLuhar, Ian M. Timæus, Rebecca Jones, Solveig Cunningham, Shivani A. Patel, Sanjay Kinra, Lynda Clarke,ReinHouben, Forecasting the prevalence of overweight and obesity in India to 2040. Feb 2020 (2):319-320.

13. Zeinalian, R., Ahmadikhatir, S., Esfahani, E.N, The roles of personalized nutrition in obesity and diabetes management: a review. J Diabetes MetabDisord, 2022, 21, 1119–1127.